FISH MANAGEMENT REPORT 106

April 1981

Bureau of Fish Management • Wisconsin Department of Natural Resources, Madison, Wisconsin

EFFECTS OF A MINIMUM LENGTH LIMIT ON THE WALLEYE POPULATION OF WOLF LAKE, VILAS COUNTY, WISCONSIN

By Steven L. Serns

ABSTRACT

A minimum size limit on walleyes (Stizostedion vitreum vitreum) in Wolf Lake was evaluated from 1971 to 1977. During 3 years with a 15-inch limit and 4 years with a 14-inch limit, the angler catch and yield of walleyes ≥15 inches varied from 0.47 to 1.88 walleyes/acre and 0.95 to 3.09 lb/acre, respectively. An increase in angler catch and yield of walleyes ≥15 inches in 1974 and 1975 was attributed to the recruitment of large 1969 and 1970 year classes. No correlation existed betweeen angler catch of walleyes ≥15 inches and their density. The number of large walleyes in the angler catch increased during the study period as did the mean length and weight of angler-caught walleyes; however, large walleyes (≥20 inches) were not as vulnerable to angling as smaller ones (<20 inches). There was a slight reduction in growth and condition of walleyes after imposition of the size limit but instantaneous total and annual total mortality rates did not change appreciably. Population density and standing crop of walleyes during the first 2 and last 2 years of the study period (1971-77) were similar. The exploitation of walleyes ≥15 inches was low and not related to their density. Large 1969 and 1970 year classes did not stockpile under the size limit as they had in a nearby lake after a size limit was established.

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INTRODUCTION

Recently there has been renewed interest among fishery managers in the use of minimum length limits to improve angling quality and maximize yields in lakes where there is a high rate of exploitation and a good rate of growth of the target species. Wolf Lake, in northwest Vilas County, presented a unique opportunity to study the effect of a minimum size limit on the walleye (Stizostedion v. vitreum). Wolf Lake was especially suitable for such a study for 2 reasons. First, its shoreline is entirely owned by a private fishing club and angling is restricted to club members. This controlled access would make possible complete creel censuses of fish harvested. Secondly, it was one of the few lakes in the state on which there was a size limit on walleyes.

During the period, 1956-69, there was no minimum length limit on walleyes and the bag limit has been 5/day since the mid-1950's. The club's fish committee established a 15-inch length limit on walleyes prior to the 1970 fishing season with the hope of increasing the quality of walleye angling (i.e., increase the angler catch of "large" walleyes). The 15-inch length limit remained in effect through 1973 but then was reduced to 14 inches prior to the 1974 fishing season to keep the walleye size limit consistent with an adjacent club lake (Serns 1978).

The data presented in this paper compares the Wolf Lake walleye population ≥15 inches with the portion <15 inches during the period, 1971-77. This comparison was designed to indicate whether or not angling quality could be improved with the size limit.

STUDY AREA

Wolf Lake, located in northwest Vilas County, Wisconsin (lat. 46°10'N; long. 89°40'W), is a 393-acre drainage lake with a maximum depth of 28 ft. Total alkalinity and conductivity are approximately 89.0 ppm and 178 μmhos/cm at 77°F, respectively, while total nitrogen and phosphorus levels at turnover are approximately 0.32 and 0.02 ppm, respectively. The concentration of total dissolved solids (TDS) calculated from total alkalinity using the formula described by Ryder (1964) is 130 ppm, and the morphoedaphic index (MEI) described by Ryder (1965) and calculated using mean depth as 0.5 maximum depth, is 9.3 (MEI = TDS ÷ mean depth).

Dissolved oxygen-temperature profiles taken quarterly in 1971 indicated a depletion of dissolved oxygen (DO) below 10 ft during the late winter stagnation period and low DO below 16 ft during the midsummer months.

The larger game and forage fishes in Wolf Lake and their relative abundance during the study period include: (1) rare - pumpkinseed (Lepomis gibbosus) and largemouth bass (Micropterus salmoides); (2) common - rock bass (Ambloplites rupestris), smallmouth bass (Micropterus dolomieui), and black crappie (Pomoxis nigromaculatus); (3) abundant - muskellunge (Esox masquinongy), yellow perch (Perca flavescens), and walleye (Stizostedion vitreum vitreum). Almost all of the fishing pressure on this lake is directed at walleye and muskellunge.

METHODS

Walleyes were caught in fyke nets during the spring spawning runs (late April - early May) in 1971, 1972, 1976, and 1977. The nets were 1-inch square mesh in 1971 and 1972 and 1-inch and 0.75-inch square mesh in 1976 and 1977. All nets were 4 ft in diameter and 16.0 ft in length and were fished with a 100- or 75-ft lead net of 1.0- or 0.75-inch square mesh. Fish were measured (total length) and sex was recorded. In a study done on a nearby lake, I found that there was no significant difference in the mean length of walleyes captured in the 1.0- vs. 0.75-inch nets in 1973 (Serns 1978), so the net catches in the 2 mesh sizes in 1976 and 1977 were combined in the present study.

Walleyes ≥15 inches were fin clipped and were tagged in 1971 with aluminum preopercular strap tags and in 1972, 1976, and 1977 with Monel butt-end jaw tags; those walleyes <15 inches were given a temporary fin clip (top of caudal fin) each year.

Instantaneous total ($\underline{Z}$) and annual total ($\underline{A}$) mortality rates were calculated by catch curve analysis (Ricker 1975) of the age frequency distribution of the combined fyke net catch in 1971-72 and 1976-77. Annual survival rates were also calculated in 1971-72 and 1976-77 for walleyes ≥15 inches using the approprite formula when recapture data were available through 2 consecutive seasons of tagging (Ricker 1975).

Bailey's modification of the Peterson method (Ricker 1975) was used to estimate the number of walleyes ≥15 inches in Wolf Lake in 1971, 1972, 1976, and 1977. Because the recapture data were obtained from a creel census extending over several months, an attempt was made to determine the effect of recruitment on the population estimates. Two estimates were calculated, one from walleyes caught in May and June only and another from walleyes caught during the entire season. For each of the 4 years, the estimates from walleye caught during the entire season were slightly higher than those caught during May and June. Because of this apparent effect of recruitment, only the estimates calculated from fish caught in May and June are presented. The number of walleyes in the 10.5- to 14.9-inch size range was estimated by the Schnabel method (Ricker 1975) using capture-recapture data on successive days of netting during the spring spawning runs. The number of walleyes <10.5 inches was not estimated because of their incomplete vulnerability to our 0.75- and 1.0-inch square mesh fyke nets.

An estimate of the standing crop of walleyes ≥15 inches was obtained by multiplying the population estimate by the mean weight of angler-caught walleyes in May and June combined. Walleye biomass in the 10.5- to 14.9-inch group in 1971 and 1972 was determined by multiplying the estimated number by the calculated weight for the mean length of walleyes of this size caught during the fyke netting period in 1972; the standing crop of walleyes in 1977 was obtained by multiplying the estimate by the calculated weight for the mean length of walleyes in this length group captured in spring 1977. Exploitation rates were determined each year through a complete creel census by dividing the number of tagged fish recaptured ($\underline{R}$) by anglers by the number marked ($\underline{M}$) prior to the fishing season. Instantaneous fishing ($\underline{F}$) and natural ($\underline{M}$) mortality rates were calculated for walleyes in 1971-72 and 1976-77 from the mean exploitation rates (μ), and instantaneous total ($\underline{Z}$) and annual total ($\underline{A}$) mortality rates in these years were calculated from the formula described by Ricker (1975).

There was a complete creel census at Wolf Lake during 1971-77. Fish were measured to the nearest 0.1 inch, weighed to the nearest 0.01 lb and were examined for tags by dock attendants who recorded these data on printed creel census forms. During the study period, walleye angling on Wolf Lake extended from the first Saturday in May to mid-October.

Scale samples were taken from the left side of the fish below the lateral line and behind the pectoral fin. Lengths at the various annuli were back-calculated for walleye collected in the springs of 1972 and 1976 and Walford (1946) lines were constructed to estimate asymptotic lengths (l_∞). Walleyes captured during the spring fyke netting periods in 1972 and 1976 were measured (total length to the nearest inch) and weighed (to the nearest 0.01 lb) for the calculation of logarithmic length-weight relationships. Condition factors of angler-caught walleyes were calculated using:

$$\underline{\bar{C}} = 10^5\ \underline{W}/\underline{L}^3$$

where $\underline{\bar{C}}$ = condition factor, $\underline{W}$ = weight to the nearest 0.01 lb and $\underline{L}$ = total length to the nearest 0.1 inch. Condition factors were averaged monthly by 1.0-inch length groups and those of walleyes caught in 1971-72 were compared to those creeled in 1975-76 by $\underline{t}$-tests.

RESULTS

A catch curve analysis (Ricker 1975) of the age frequency of the combined net catches of 1971 and 1972 vs. those collected in 1976 and 1977 indicated little change in instantaneous total ($\underline{Z}$) and annual total ($\underline{A}$) mortality rates for walleyes ≥age VII during these 2 periods (Table 1). The large 1969 and 1970 year classes precluded an analysis of the mortality of walleyes ≥age VII in the 1976-77 catch. However, there did not seem to be much difference in the age-specific mortality rates for adult walleyes in Wolf Lake, as the 1971-72 catch curve indicated only slight differences in the mortality of walleyes ≥age III, V, and VII and the annual rate of survival ($\underline{S}$) was nearly the same for walleyes <age VII in 1976-77 and for those ≥15 inches (~≥age V) in 1976 (Table 1, footnote). The annual rates of mortality for walleyes in Wolf Lake are similar to those reported for walleyes in other Wisconsin lakes (Mraz 1968; Kempinger and Carline 1977; Serns 1978).

There appeared to be sparse natural reproduction in 1972 and 1973, as indicated by the small number of walleyes in the 10.0- to 13.9-inch length group and the absence of age III and IV fish from the age frequency distribution in 1976. The large number of walleyes in the 11.0- to 12.9-inch groups in 1977 belong to the 1974 year class (age III) which apparently was another large year class (Tables 1 and 2).

Table 1. Age frequency of walleyes captured in fyke nets in Wolf Lake in 1971-72 and 1976-77, with catch curve estimates of $\underline{Z}$, $\underline{A}$ and $\underline{S}$.[a]

Age		Number of Fish in each Age Group				
	1971	1972	1971-72	1976	1977	1976-77
III		143	143		212	212
IV	59	46	105		51	51
V	54	46	100	30	9	39
VI	30	47	77	42	58	100
VII	16	18	34	111	140	251
VIII	10	8	18	59	188	247
IX	7	5	12	28	61	89
X	4		4	33	8	41
XI	1		1	20		20
≥Age III $\underline{Z}$			0.589			
$\underline{A}$			0.445			
$\underline{S}$			0.555			
≥Age V $\underline{Z}$			0.637			
$\underline{A}$			0.473			
$\underline{S}$			0.527[b]			
≥Age VII $\underline{Z}$			0.683			0.685
$\underline{A}$			0.493			0.498
$\underline{S}$			0.507			0.502[c]

[a]notation follows Ricker (1975) where $\underline{Z}$ = instantaneous rate of total mortality, $\underline{A}$ = annual rate of total mortality, and $\underline{S}$ = annual rate of survival.

[b]agrees closely with annual survival estimate for walleyes ≥15 inches (~age IV-V and older) of 0.466 in 1971 using Ricker's formula:

$$S = \frac{\underline{R}_{12},\ \underline{M}_2}{\underline{M}_1,\ \underline{R}_{22}}$$

[c]agrees closely with annual survival rate estimate for walleyes ≥15 inches (~age V and older) of 0.504 in 1976 using Ricker's formula (as noted in footnote b above).

Table 2. Number of walleyes caught/10 net-days during spring fyke netting periods in Wolf Lake in 1971, 1972, 1976, and 1977.

Total Length (inches)	Number of Fish Caught			
	1971 (12)[a]	1972 (8)	1976 (18)	1977 (16)
10.0-10.9	0.0	16.3	0.0	12.5
11.0-11.9	4.2	121.3	0.0	62.5
12.0-12.9	4.2	51.3	2.2	61.3
13.0-13.9	19.2	27.5	1.0	11.3
14.0-14.9	38.3	37.5	8.0	10.6
15.0-15.9	42.5	45.0	20.0	15.0
16.0-16.9	1.7	26.3	21.1	26.0
17.0-17.9	6.7	25.0	33.9	36.9
18.0-18.9	3.3	9.0	25.0	35.0
19.0-19.9	3.3	5.0	20.0	39.4
20.0-20.9	8.3	17.5	21.1	48.8
21.0-21.9	3.3	3.8	8.9	42.5
22.0-22.9	3.3	2.5	6.1	23.1
23.0-23.9	4.2	1.3	7.8	13.8
24.0-24.9	3.3	2.5	7.2	7.5
≥25.0	0.8	0.0	3.9	8.8
Mean Length (inches)	15.9	14.0	19.2	19.8
% <15 inches	45.0	64.8	6.0	34.8
% ≥15 inches	55.0	35.2	94.0	65.2
% ≥20 inches	15.8	7.0	29.5	31.8

[a]Number of net days effort are in parentheses.

Length and Age Distribution

The mean length and number of large walleyes (≥20 inches) in the net catch increased between 1971-72 and 1976-77. In 1972, a large number of walleyes in the 11.0- to 12.9-inch length group were captured in the fyke nets; these fish were identified by scale-reading as the 1969 year class. The effect of this large year class and the 1970 and 1971 year classes upon the length frequency distribution in 1976 and 1977 was an increase in the number of large walleyes in the 1976 and 1977 fyke net catch (Table 2).

There was a decrease in the percentage of walleyes <15 inches in the fyke net catch between 1971-72 and 1976-77 (Table 2). This was probably due to the recruitment of the 1969-71 year classes to the ≥15-inch length range by 1976 and 1977 and limited reproduction in 1972 and 1973.

Population, Standing Crop, and Mortality Rate Estimates

The density of walleyes in the 10.5- to 14.9-inch group was high in 1972 (8.0/acre) and 1977 (5.0/acre) due to the recruitment of large 1969 and 1974 year classes (Table 3). Standing crop estimates were also highest in those years (4.6 and 2.9 lb/acre, respectively). The number of walleyes ≥15 inches remained fairly constant in the years following the imposition of the size limit. The population density was highest in 1972 (8.1/acre) but fairly similar in 1971, 1976, and 1977 (approx. 5.1/acre). The standing crop also was highest in 1972 (15.4 lb/acre) with the biomass being similar in the other years: 1971 = 7.9 lb/acre, 1976 = 8.6 lb/acre, and 1977 = 9.6 lb/acre (Table 3).

The exploitation rate of walleye ≥15 inches varied from 0.057 in 1972 to 0.123 in 1976 with a mean rate of exploitation for the 4 years of 0.086. There was no correlation between the density of walleyes ≥15 inches and their rate of exploitation (r = -0.70, df = 2, P > 0.05). Instantaneous fishing (F) and natural (M) mortality rates for ≥age VII walleyes in 1971-72 were 0.109 and 0.574, respectively, compared with F and M values for walleyes ≥age VII in 1976-77 of 0.129 and 0.556, respectively. Using annual rate of survival (S; Table 1) calculated with Ricker's (1975) formula:

$$S = \frac{R_{12}, M_2}{M_1, R_{22}}$$

the F and M values for walleyes ≥15 inches (~≥age V) were 0.143 and 0.620, respectively, in 1971 and 0.089 and 0.594 in 1976.

The density and standing crop of walleyes in Wolf Lake is similar to that for walleye populations described in the literature; however, the exploitation rate for walleyes in Wolf Lake is considerably lower than that found in other studies (Olson 1958; Forney 1967; Carlander and Payne 1977; Kempinger and Carline 1977; Schneider 1978).

Angler Harvest

Both angler catch and yield varied considerably during the 7-year period from 1971 to 1977 (Table 4), and there was apparently no correlation between the catch of walleyes ≥15 inches and their density for the 4 years that data were available (r = -0.43, df = 2, P > 0.05). The effect of the large 1969 and 1970 year classes on the catch and yield of walleyes ≥15 inches was evident during 1974 and 1975, the 2 years when they were first recruited into this size range. These year classes also caused an increase in the mean length and weight of angler-caught walleyes during the study period.

From 1974 through 1977, after the size limit was reduced to 14 inches, only 24% of the total catch and 14% of the total yield of walleyes ≥14 inches was comprised of walleyes in the 14.0- to 14.9-inch length range. During the period of 1974 through 1977, less than 2% of the anglers caught a daily bag limit and no angler caught a limit composed only of fish <15 inches. Therefore, I do not feel that the size limit reduction influenced the angler catch and yield of walleyes ≥15 inches from 1974 through 1977.

The length frequency distribution of the angler catch of walleyes ≥15 inches indicates the recruitment of the 1969 year class to the 15.0- to 16.9-inch size group in 1974 and to the 16.0- to 17.9-inch length group in 1975 (Table 5). The effect of the 1970 year class on the angler catch in 1975 is evidenced by the large number of fish in the 15.0- to 15.9-inch group that year.

Table 3. Population density, standing crop, and exploitation rate estimates of Wolf Lake walleyes in 1971, 1972, 1976, and 1977.

	Total Length 10.5-14.9 inches		Total Length ⩾15 inches			
Year	Population Density (no./acre)	Standing Crop (lb/acre)	Population Density (no./acre)	Standing Crop (lb/acre)	Exploitation Rate (μ)	Ratio of walleyes 10.5-14.9 inches: ⩾15 inches
1971	1.6(0.4-7.2)[a]	1.4(0.4-6.5)[b]	5.0(2.4-12.3)	7.9(3.5-12.3)	0.100	0.32
1972	8.0(4.1-20.0)	4.6(2.3-11.3)	8.1(2.7-13.6)	15.4(4.6-26-2)	0.057	0.99
1976	c		4.9(3.5-6.3)	8.6(6.1-11.0)	0.123	
1977	5.0(4.0-7.3)	2.9(2.3-4.3)	5.2(3.3-7.1)	9.6(6.0-13.2)	0.065	0.96

[a]95% confidence limits are in parentheses.

[b]An estimate of standing crop was determined by multiplying the estimated density of walleyes in the 10.5- to 14.9-inch group in 1971 by the calculated weight for the mean length of walleyes in this size group netted in 1971 using the length-weight relationship formula ($\log \underline{W} = 3.0470 \log \underline{L} - 3.5284$) calculated for walleyes captured in 1972.

[c]Too few captured during spring netting to estimate.

Table 4. Angler harvest of walleyes from Wolf Lake from 1971 through 1977.

Size Range and Year	Catch (no./acre)	Mean Total Length (inches)	Mean Weight (lb)	Yield (lb/acre)
Total length ⩾15 inches				
1971	0.64	16.7	1.65	1.08
1972	0.53	17.5	1.94	0.99
1973	0.58	17.1	1.71	1.00
1974	1.88	16.8	1.64	3.09
1975	1.55	17.4	1.86	2.85
1976	0.73	17.5	1.80	1.32
1977	0.47	17.9	1.95	0.95
Total length 14.0-14.9 inches				
1974	0.77	14.5	0.94	0.71
1975	0.46	14.3	0.91	0.42
1976	0.13	14.3	0.88	0.11
1977	0.11	14.4	0.90	0.10

The percentage of walleyes ≥20 inches in the angler catch (Table 5) increased during the 7-year period from grand averages of 9.6 from 1971-73 to 15.3 from 1975-77. However, larger walleyes were apparently not as vulnerable to angling as the smaller ones. For 1976-77, the combined percent exploitation of walleyes 15.0 to 19.9 inches long was 12.0% while the percentage of walleyes ≥20 inches caught by anglers was only 4.8%. Walleyes 15.0-15.9 inches were usually caught in proportionately greater numbers by anglers than by nets, while walleyes ≥20 inches were creeled to a lesser degree than they were captured by fyke nets (Table 5). Also, the mean length of walleyes ≥15 inches in the fyke net catches in 1976 and 1977 was 19.2 and 19.8 inches, respectively, while the mean length of angler-caught walleyes ≥15 inches in May of these years was 17.5 and 17.6 inches, respectively. Reduced vulnerability to angling of larger walleyes was also noted in Escanaba Lake (Serns and Kempinger 1981). Possible reasons for this phenomenon are : (1) differences in the behavior of large and small walleyes, and (2) bait size which generally favors harvest of smaller walleyes.

Angler catch rates for walleyes ≥15 inches from May-August increased from 1972 through 1974 (Table 6). This increase can mainly be attributed to the recruitment of the large 1969 year class to the population ≥15 inches by the opening of the fishing season in 1974. This 1969 year class was also evident in the estimated number of walleyes ≥15 inches caught in 1973 (Table 6).

Fishing success was usually highest in May and June, normally the months of greatest fishing effort (Table 6). The catch rates of walleyes in Wolf Lake were slightly lower in 1972 and 1973 than those reported elsewhere (Olson 1958; Forney 1967; Kempinger et al. 1975); however, the catch rate in 1974 was similar to that reported in these other studies. Many of the voluntary fishing success forms used to calculate the catch rates mentioned above were returned with unsuccessful fishing time recorded. Therefore, I do not feel that these data are biased toward the successful angler. Not enough forms were returned in September and October to allow for a satisfactory calculation of catch rates during these months.

Fishing effort estimated from 1972 through 1974 was fairly constant and dock attendants, club managers, and several anglers reported that they observed no obvious change in fishing effort on Wolf Lake through the 7-year study. The estimates of fishing effort on Wolf Lake (Table 6) during the May-August periods of 1972-74 (6.5-8.4 hours/acre) were considerably less than those reported on similar-sized lakes in the same area of Wisconsin. McKnight and Serns (1974) found an average effort of between 16.2 and 20.2 hours/acre from June to August on 3 northeastern Wisconsin lakes with surface areas between 522 and 599 acres.

<u>Age, Growth, and Condition</u>

There was a decrease in weighted mean total lengths at the most recent annulus for both male and female walleyes ≥age VI in Wolf Lake from 1972 to 1976 (Table 7). The growth of walleyes in Wolf Lake was above average when compared with walleye growth in other lakes in northern Wisconsin (unpublished data from Wis. Dep. Nat. Resour. Burs. of Res. and Fish Manage.). Walford (1946) lines calculated using mean back-calculated lengths (sexes combined) of walleyes collected both in 1972 and 1976 (Serns, unpublished data) indicated a decrease in ultimate attainable lengths (l_∞) from 29.1 inches in 1972 to 27.4 inches in 1976.

The length-weight relationship formula (length to nearest 0.1 inch and weight to nearest 0.01 lb) for 155 walleyes collected in April 1972 was $\log W = 3.0470 \log L - 3.5284$ ($r = 0.972$) compared with $\log W = 3.0126 \log L - 3.5106$ ($r = 0.951$) for 240 walleyes collected in April 1976. Calculated weights for given lengths were slightly lower for walleyes collected in 1976 when compared to those captured in 1972 using the respective length-weight formula.

Mean condition factors ($\bar{C}$) were usually higher for walleyes caught by anglers in 1971-72 than those creeled in 1975-76 (Table 8). For each length group, both in 1971-72 and 1975-76, there appeared to be an increase in $\bar{C}$ from spring to fall. this may be due to post-spawning increases in weight through the summer or the result of a change in diet from May through October (Serns, unpublished data).

Table 5. Percentage of the total fyke net (FN) and angler (A) catch of walleyes ⩾15.0 inches in various total length groups from 1971 through 1977.

Year	Method	Total Length Range (inches) 15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	⩾20.0
1971	FN	52.6	2.1	8.2	4.1	4.1	28.9
	A	52.6	18.7	11.6	8.0	2.0	7.1
1972	FN	32.8	19.0	18.2	6.4	3.6	20.0
	A	24.5	24.5	17.3	13.5	7.2	13.0
1973	A	30.7	22.8	17.1	12.3	7.9	9.2
1974	A	39.7	24.7	15.6	7.6	4.3	8.1
1975	A	25.5	25.0	17.0	11.0	6.8	14.7
1976	FN	11.4	12.1	19.4	14.3	11.4	31.4
	A	29.4	23.1	18.5	10.8	6.3	11.9
1977	FN	5.1	8.8	12.4	11.8	13.3	48.6
	A	25.0	17.2	18.3	9.5	7.2	22.8
Mean	FN	25.5	10.5	14.5	9.1	8.1	32.2
	A	32.2	22.3	16.5	10.4	6.0	12.4

Table 6. Angler catch rates for Wolf Lake walleyes from May-August, 1972 through 1974, with estimated fishing effort.

Year	Month	Catch Rate of Walleyes (fish/hour) ⩾15 inches	<15 inches	No. Walleyes in Catch ⩾15 inches	<15 inches	Estimated Total Fishing Effort (hours/acre)
1972	May	0.14	0.21	112	168	2.0
	June	0.04	0.11	58	160	3.7
	July	0.02	0.12	5	30	0.9
	August	0.02	0.01	14	7	1.8
	May-August	0.06	0.11	189	365	8.4
1973	May	0.12	0.30	122	305	2.6
	June	0.13	0.47	47	170	0.9
	July	0.05	0.09	43	77	2.2
	August	0.03	0.06	9	18	0.8
	May-August	0.09	0.22	221	570	6.5
1974	May	0.53	0.09	485	82	2.3
	June	0.13	0.13	176	176	3.4
	July	0.10	0.10	8	8	0.2
	August	0.04	0.04	12	12	0.8
	May-August	0.26	0.10	681	278	6.7

Table 7. Weighted mean total lengths (inches) at most recent annulus of male and female walleyes collected in April 1972 and April 1976 in Wolf Lake.

Annulus	Males		Females	
	1972	1976	1972	1976
3	11.7(59)[a]			
4	13.7(29)	13.7(4)	14.6(1)	
5	15.1(33)	15.2(23)	16.0(5)	16.9(1)
6	16.4(30)	16.3(24)	17.7(12)	16.0(5)
7	19.0(4)	17.0(40)	19.3(13)	18.5(22)
8	20.0(1)	18.7(9)	21.1(5)	19.9(18)
9	22.2(2)	20.8(4)	23.2(3)	20.8(10)
10		21.0(2)		23.1(9)
11		23.2(1)		24.2(5)

[a]Sample sizes are in parentheses.

Table 8. Comparison of condition factors ($\underline{\bar{C}}$) of angler-caught walleyes ≥15.0 inches in 1971-72 vs. those in 1975-76.[a]

Size Range (inches)	Month	Mean Condition Factor ($\bar{C}$)	
		1971-72	1975-76
15-15.9	May	33.04(66)	32.06(117)
	June*	34.56(38)	32.80(49)
	July-Aug.*	34.69(37)	31.21(30)
	Sept.-Oct.**	34.68(31)	31.88(41)
16-16.9	May**	33.35(35)	31.61(135)
	June	35.20(41)	34.62(37)
	July-Aug.	35.43(14)	34.41(16)
	Sept.-Oct.	36.00(8)	33.03(29)
17-17.9	May	33.51(30)	32.94(104)
	June	33.64(21)	34.39(26)
	July -Aug.	33.32(6)	33.85(9)
	Sept.-Oct.	33.96(11)	29.34(13)

[a]Asterisks denote a significant difference between years at $*\underline{P} < 0.05$ or $**\underline{P} < 0.01$ (2-tailed $\underline{t}$-test).

DISCUSSION

During the years (1971-77) following the imposition of a 15-inch length limit, the growth and condition of walleyes in Wolf Lake declined slightly. This slight decrease may have been due, in part, to the large 1969 and 1970 year classes causing increased intraspecific competition for available forage. The slight decline in growth, however, was not enough to cause a stockpiling of fish under the size limit as occurred with walleyes in Big Crooked Lake (Serns 1978) and largemouth bass in several Missouri impoundments where size limits were established (Farabee 1974; Johnson and Anderson 1974; Rasmussen and Michaelson 1974).

The percent exploitation of walleyes between 15.0 and 19.9 inches was nearly 3 times greater than that for walleyes ⩾20 inches indicating a reduced angling vulnerability of larger walleyes in Wolf Lake. A possible explanation for this occurrence is that large fish can utilize a wider range of prey sizes and therefore have a greater available food supply. This increase in available prey may cause a decrease in exploitation of these larger walleyes. Other investigators have suggested that the vulnerability of walleyes to exploitation is inversely related to prey abundance (Forney 1967; Kempinger et al. 1975). This lower vulnerability to angling of larger walleyes might reduce the yield benefits expected from an increase in the number of large fish in a population after protection by a minimum length limit.

Even with a low mean rate of exploitation in Wolf Lake (0.086), the size limit did not cause a stockpiling of fish under the minimum length limit. Apparently the good forage base (yellow perch) and medium fertility (both of which probably positively influenced walleye growth), coupled with erratic recruitment, discouraged the formation of this bottleneck. The size limit was well accepted by fishermen and is still in effect at Wolf Lake (as of 1980).

Prior to the establishment of minimum size limits, walleyes were growing at an above-average rate in Wolf Lake and below normal in adjacent Big Crooked Lake (Serns 1978) when compared to the average rate of growth for walleyes in several northern Wisconsin lakes. However, walleyes in northern Wisconin typically grow at slower rates than reported in other midwestern states (Olson 1958; Carlander and Payne 1977; Schneider 1978). The disparity in the effects of a minimum length limit on the walleye population of Wolf and Big Crooked lakes (Serns 1978) which are located within 1,500 ft of each other illustrates the fallacy of imposing uniform size limits statewide, regionally, or even locally. The walleye population of Big Crooked Lake was managed by the same set of regulations as were walleyes in Wolf Lake; however, in Big Crooked Lake, the size limit caused significant decreases in growth and condition, and a "stockpiling" of walleyes beneath the minimum length due to the severely reduced rate of growth (Serns 1978). Possible reasons for the differences in the effects of minimum length limits on walleyes in Wolf and Big Crooked lakes are: (1) the contrast in water hardness and potential biological productivity in these 2 water bodies, and (2) differences in prey abundance.

A regression of Ford's growth coefficient ($\underline{k}$) (Ricker 1975) on both total alkalinity and morphoedaphic index for 23 northern Wisconsin lakes (unpublished data from Wis. Dep. Nat. Resour.) indicated no correlation between these parameters ($\underline{r}$ = 0.047 for $\underline{x}$ = total alkalinity and $\underline{r}$ = -0.085 for $\underline{x}$ = morphoedaphic index; Ryder 1965), suggesting that the difference in alkalinity between Wolf and Big Crooked lakes alone would not account for the difference in walleye growth. The disparity in the effects of the length limit on walleye growth in these 2 lakes is probably better explained by the more desirable food supply in Wolf Lake (many yellow perch in the 2- to 8-inch length range) than in Big Crooked Lake (some young-of-the-year and ⩾9-inch yellow perch but few between 2 and 8 inches) (Serns, unpublished data).

Until a more sophisticated level of fish management is reached whereby length limits may be imposed on walleyes in individual water bodies based on their potential for biological productivity and predator-prey characteristics, a size limit that allows for the best management of the majority of the walleye populations in a region must be employed. In most of the lakes in northern Wisconsin where the majority of the state's walleye lakes are located, walleye growth rates are slow to average and the potential for biological production is low to moderate. Considering this, the present no size limit regulation (in effect in 68 of 72 Wisconsin counties according to the 1981-82 fishing regulations) probably affords the best utilization of the walleye populations in the majority of the state's lakes.

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ACKNOWLEDGMENTS

I would like to thank the fish committee and members of the fishing club where this study was conducted. Their interest and assistance made the study possible. I also appreciate the help of the dock attendants who took special care in recording the creel census data. R. F. Carline and R. L. Kendall critically reviewed an earlier draft of the manuscript. I appreciate the use of walleye growth data from northwestern Wisconsin compiled by H. Snow and T. D. Beard.

Edited by Susan Nehls

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